Riverine Carbon and the Sedimentary Record on the Continental Shelves

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LONG-TERM GOALS

The long-term goal of our research is to improve the understanding of the behavior of terrestrial organic carbon on continental shelves. More specifically this project seeks to link the rates, the routes and the fate of organic carbon to the continental-margin sediment dynamics.

OBJECTIVES

The field work is carried out in the northern Adriatic margin in the framework of the EuroSTRAFORM program. Our approach is to use the signature of the organic matter in order to: 1) trace the initial distribution of flood sediments on the shelf (spatial variability); 2) trace the physical and biological reworking of the flood layer (temporal variability); 3) discriminate between Po and Apennine riverine inputs; 4) identify flood layers in the stratigraphic records; 5) estimate the particulate organic carbon discharged during the 2000 flood event; 6) evaluate the overall organic carbon accumulation on the Adriatic continental shelf at monthly and 100-year time scales; 7) provide the overall partition between terrestrial and marine origin of the organic matter, based on a refined assessment of the end-member values of $\delta^{13}C$.

APPROACH

An opportunity to directly follow riverine particulate matter on a continental shelf over monthly and yearly time-scales was provided in late October 2000, when the Po River in the Northern Adriatic experienced a major flood. Rapid response cruises were carried out soon after the flood reached the sea; a hydrological survey for the characterization of the plume and a box coring cruise for sediment sampling was carried out. Po prodelta stations were re-occupied several times each year at seasonal frequency. Starting from April 2002 investigations were extended along the Apennine margin. The field work ended in May-June 2003.

C_{org} content, carbon stable-isotope composition and C/N ratio were determined on sediments and suspended matter collected in order to characterize organic matter. The isotopic composition of organic matter in marine sediments is often used to identify its source and transport pathways. The isotopic composition of organic particles may result, among principal causes, from the biological sources of the particles (marine or terrestial) allowing to determine the relative proportions of marine and terrestrial organic carbon (Faganeli et al., 1988, Middelburg and Nieuwenhuize, 998).

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14. ABSTRACT

The long-term goal of our research is to improve the understanding of the behavior of terrestrial organic carbon on continental shelves. More specifically this project seeks to link the rates, the routes and the fate of organic carbon to the continental-margin sediment dynamics.

15. SUBJECT TERMS

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WORK COMPLETED

Box cores and suspended matter were collected near the Po delta in December 2000, 1 month after the major flood. Sample collection was repeated in January 2001, June 2001, October 2001, January 2002 and April 2002. During the last cruise was investigated also the central Adriatic shelves. During FY2003 three more oceanographic cruises were conducted comprising both Po prodelta environment and Apennine margin. Approximately a total of 500 surface sediment and 700 suspended matter samples have been collected for carbon stable-isotope, C_{org}, and N analyses. Most of these analyses have been completed. Sediment vertical profiles from selected box and kasten core were also sampled. These analyses were started.

In addition the ISMAR-SGM has supported the fieldwork by providing logistical help (lab and office space, refrigerator storage, field equipment, vessel use, and relationship with local authorities) to researchers involved in the EuroSTRATAFORM program.

RESULTS

In December 2000, soon after the flood, the highest concentrations of C_{org} (up to 1.24 wt%) were measured in front of each main distributary mouths (Po della Pila, Po di Tolle and Po di Gnocca/Goro) at water depths increasing southward (from 12 to 21 m depth) along the main sediment dispersal system (Fig.1). These areas roughly match those characterized by the highest thickness of the Fall-2000 flood deposit. The dispersal patterns of C_{org} in June 2001 and October 2001 were similar but peak contents were recorded closer to the coast. In April 2002, maximum C_{org} values were found in 15-20 m water depth in the area SE of Po della Pila, whereas the southern mouths seemed to be less active.

The $\delta^{13}C$ of organic matter was used to trace the dispersion of riverine C_{org} on the continental shelf. The $\delta^{13}C$ values ranged from –25.92 ‰ to –23.07 ‰ during December 2000 cruise. The contribution of river-born organic particles decreased with increasing water depth, following a radial dispersal pattern. The signature of terrestrial C_{org} is almost lost at about 9 km across the shelf from the Po river's mouths. The $\delta^{13}C$ distribution on surface sediment and the flood layer thickness (obtained from x-ray photographs) match well because both are depending from the riverine input and not influenced by grain size.

The temporal variability of organic carbon contents and stable isotopes in surface prodelta sediments was investigated. After the Fall-2000 flood of the Po River, the organic matter shows a progressive increase of the marine signature with time. (Fig. 2) Only after 2 years from the flood event, it is becoming apparent the effect of the biological mixing and physical reworking that have altered the original signal of organic carbon and $\delta^{13}C$ (Oct 02). On the contrary, early diagenesis seems not to affect effectively the carbon profiles in rapidly-accumulating sediments.The organic carbon content of surface sediments collected during 2 cruises (April 2002 and October 2002) in the Po prodelta and along the Apennine margin follows the same pattern of fine sediment dispersal. The highest values (from 0.60 to 1.71 wt%) were recorded close to the Po river delta, while in the central Adriatic the contents range from 0.11 to 0.91 wt%, with slightly higher values toward the bottomset region and negligible along-shelf variability.

The isotopic composition of organic matter in marine sediments is often used to identify its source and transport pathways. On the basis of suspended matter and sediment collected both in fluvial and

marine environments, we have determined $\delta^{13}C_{org}$ values of -18.5‰ as end member for marine organic matter and -26.5 ‰ for terrigenous. The sedimentary $\delta^{13}C_{org}$ values in the central Adriatic Sea suggest an overall dominance of the organic matter of terrestrial origin and a stronger influence of terrigenous organics close to the mouths of the Chienti, Pescara and Sangro rivers.

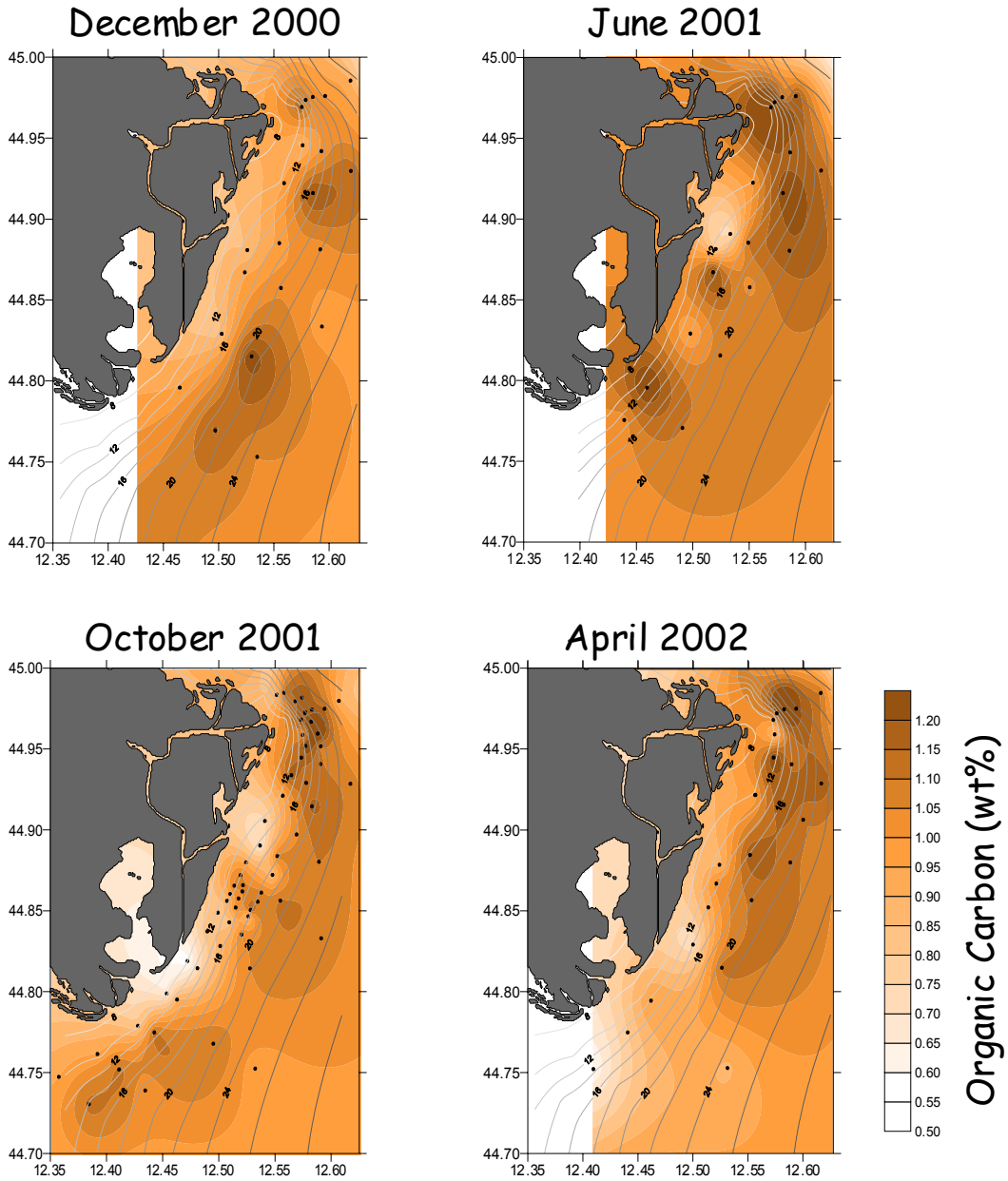

Figure 1. Distribution of C_{org} content on surface sediment from the Po prodelta area during different seasonal cruises.

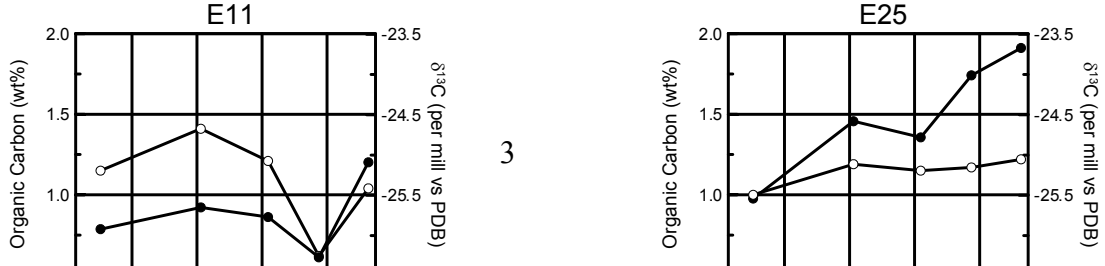

Figure 2 – Time evolution of organic carbon content (open circle) and $\delta^{13}C$ (filled circle) in surficial sediment of the Po River prodelta. Repeated sampling of the same stations shows that $\delta^{13}C$ values increase progressively through time.

IMPACT/APPLICATIONS

Studying the sedimentary processes that affect the distribution and preservation of organic matter on the continental shelves, will provide key insight to understand the role this environment as sinks for C_{org} with respect to the global carbon cycle.

TRANSITIONS

No transitions, see related projects.

RELATED PROJECTS

Our research is related with several other EuroSTRAFORM groups. In detail stringent collaboration is active with: Chuck Nittrouer (UW) which provide dates for recent surface sediments; Paul Hill (UDal) and Tim Milligan (BIO) in order to inspect the relationships between organic carbon content and particle grain size; and with Rob Wheatcroft (OSU) to characterize the role the biological and/or physical reworking of the flood layer.

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